

**BROOKHAVEN NATIONAL LABORATORY**

# **OCCUPATIONAL HEALTH AND SAFETY GUIDE**

<b><i>MEANS-OF-EGRESS (EXITS)</i></b>	<b>4.1.2</b>
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## **I. INTRODUCTION**

This Guide is concerned with the minimum level egress design for life safety (exiting the facility during an emergency). The prompt and safe egress from a building is usually the single most important element in the overall life safety design. There is a large area of disagreement as to what constitutes reasonable life safety in any given case. DOE has established that OSHA CFR 1910 and NFPA 101 are the minimum standards for safe exiting in an emergency.

This Guide does not conflict with the detailed and often complex provisions of the "Life Safety Code." Rather, it presents general principles of safe egress design to assist BNL staff in interpreting the "Life Safety Code" in the context of Laboratory facilities, and details provisions of egress design for problem areas at the Laboratory.

## **II. SCOPE**

A. This Guide outlines general principles needed for personnel safety from fire, smoke, fumes, or panic in emergency egress from BNL buildings. These principles may also be applicable to designs for egress from other hazardous conditions, such as cryogenics or radiation.

B. The "Life Safety Code," National Fire Protection Association Standard No. 101, contains the criteria for means-of-egress design, construction, and maintenance at Brookhaven National Laboratory. This Guide outlines means-of-egress features most applicable to users of the facilities at BNL; and it complements the provisions of NFPA 101.

C. Trailers, other mobile structures, or "temporary" structures when in a fixed location and occupied as buildings, are to be considered buildings requiring safe means-of-egress as outlined in this Guide.

## **III. DEFINITIONS**

The definitions below have the limited technical meanings indicated, and are intended to be consistent with the definitions found in the "Life Safety Code."

A. **Building.** Any structure used or intended for supporting or sheltering any use or occupancy.

B. **Means-of-Egress.** The total route from an area in an occupied building to a safe outdoor location.

C. **Exit.** A portion of the total means-of-egress that is separated from all other spaces of a building and therefore provides a safe protected route to the outdoors. One type of "exit" is a door into an enclosed, (such as an adequately enclosed stairway) which allows occupants to proceed in relative safety to the outside. A second type of "exit" is a door from a room or area direct to the outside. A third type of "exit" is a door through a fire separation wall to another portion of a building (or another building), from which safe access to the outside is provided. The term "exit" implies a transference from an area where the occupant is exposed directly to the dangers of fire to an area of safe refuge where urgency for further escape is not present.

D. **High Hazard Area.** Any area requiring means for rapid egress because of the potential exists for extremely rapid flame spread, explosion, or release of highly toxic materials.



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E. **Life Safety Code.** The most recent version of the National Fire Prevention Association's Life Safety Code (NFPA-101). The NFPA issues a handbook which is invaluable as an aid to interpretation.

F. **Occupancy.** The purpose to which a building or portion thereof is used or intended to be used.

G. **Occupant Load.** The number of persons occupying a space at any time.

### IV RESPONSIBILITIES

A. **Department Chairmen/Division Heads** (or a designated alternate) are responsible for ensuring:

1. Any new or modified facilities comply with this Guide.
2. Assuring that adequate means of egress are maintained.
3. Pursuing funding for correction of identified deficiencies.
4. Ensure review of alternations effecting means of egress.
5. Facilities not in compliance with the Life Safety Code have an equivalent level of protection. (See Section V.)

B. **Supervisors, Users, and Building Occupants** are responsible for complying with the provisions of this Guide. Specifically, they shall:

1. Maintain all means-of-egress clear and unobstructed as required by the administrative sections of the Life Safety Code.
2. Submit proposed means-of-egress designs and changes to the S&EP Division (through the Department/Division Safety Coordinator) for review.

C. **Project Design Group or Plant Engineering Division** are responsible for adhering to the "Life Safety Code" and this Guide in the design of new construction or alterations to existing structures, and submitting proposed designs to the S&EP Division for review.

D. **Safety and Environmental Protection (S&EP) Division** is responsible for providing staff assistance in the implementation of this Guide. Specifically, the S&EP Division shall:

1. Assist in the interpretation of the provisions of the "Life Safety Code" and this Guide.
2. Review designs and proposals for conformance with the "Life Safety Code" and this Guide.
3. Make recommendations to Safety Coordinators on deficiencies noted during inspections.
4. Aid the departments in preparing exemption request for deviations from the Life Safety Code.

### V. EQUIVALENCY CONCEPTS

DOE Facilities must comply with the intent of the Life Safety Code. This can be accomplished by either 1) strict compliance with requirements of NFPA 101 or 2) establishing a level of equivalency, i.e. equal level of Life Safety, as outlined in Section 1-5 of NFPA-101. It must be emphasized that an equivalence is not a waiver. The Fire Protection Staff should be consulted to determine what systems are equivalent or superior. Pursuing a level of equivalency requires documentation and DOE concurrence through the exemption approval system (OHS 4.0.0, Section I-B).

### VI GENERAL FEATURES

#### A. OCCUPANCY

1. One important consideration in the means-of-egress design is the occupancy, that is, the use to which a building or space is put. Evacuation times are related to the fire hazard of the occupancy: as the hazard increases (i.e., the faster the space is likely to become unsafe for the occupants), the allowable time for evacuation decreases. In addition, the general physical and psychological characteristics of the occupant



population must be considered, since various occupancy groups will require somewhat different design features. Appendix A lists various occupancies at BNL in relation to occupancy classifications found in the "Life Safety Code."

2. A change in building occupancy, whether necessitating a physical alteration or not, is to be made only where the existing means-of-egress are adequate for the new occupancy, or after additional means-of-egress features have been provided as necessary.

3. **Special Purpose Occupancies.** There are practical limits on the means-of-egress design in many special purpose occupancies found at BNL. There may be little life safety gains in a "standard" means-of-egress from the center of a large machine or equipment installation where there are no occupants under normal operating conditions. In many operations, machine control is conducted from a remotely located control room. Personnel are not normally in the area except for maintenance and adjustment purposes, and then only on a limited basis. If provisions for travel distance and the capacity of the means-of-egress in a special purpose occupancy were based on the requirements specified for general industrial occupancies, the result may be extensive egress facilities for nonexistent occupants resulting in severe economic penalties in the name of safety. Such arrangements might actually result in "standard" means-of-egress being required from the interior of machinery and equipment, an idea incompatible with the equipment's design. In some cases these may be from locations which even under normal operating conditions would be considered dangerous for humans. Poorly conceived egress facilities serve no life safety purpose and detract from an otherwise well-designed evacuation system.

## B. OCCUPANT LOAD

A second important consideration in means-of-egress design is the occupant load. The design capacity is to be sufficient for the maximum occupant load, which is the number of persons that may occupy the space at any given time, but is not less than the number computed in accordance with Appendix B. The "normal" number of occupants is not necessarily a suitable criterion for judging the adequacy of the means-of-egress design, as the greatest hazard may exist when an unusually large number of people are present. Experience has also shown that administrative limits on the number of occupants allowed in a space usually are not effective.

## C. ARRANGEMENT

1. **Number.** Fire or smoke may prevent the use of one means-of-egress. Normally, means-of-egress are arranged so that each occupant has free and unobstructed access by separate travel paths to at least two exits remote from each other. A single means-of-egress is permissible where the space is small and arranged so that a second route would not provide an appreciable increase in safety, and if all the following conditions exist:

- a. The occupant load is less than 25 persons.
- b. The total travel distance to the exit is less than 50 feet.
- c. The exit discharges directly to the outside at ground level.
- d. A fire detection or sprinkler system is present with alarm devices that can be heard by occupants.
- e. The occupancy is not a health care facility (e.g., the hospital) or a high hazard area.

2. **Remoteness of Exits.** While the concept of remote exits is a simple one, many questions arise concerning its application. There is no simple formula to determine remoteness. Compliance with the following formulas is considered adequate:

- a. the distance between exits is to be not less than two-thirds the largest dimension of the area (rectangular areas)
- b. the distance between exits is to be not less than one-half the maximum overall diagonal dimension of the area (nonrectangular areas). In both cases, the distance is measured in a straight line between the exits.

3. **Discharge of Exits.** Exits normally are to discharge directly to an outside location which allows occupants safe access to a road or other public way. When discharge into a court or yard, access to a road must be such that the direction is clear and unincumbered. **Under some conditions**, up to 50% of the exits may discharge



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through lobbies, corridors or other areas on the floor level of discharge, or to a 'roof.' These conditions are detailed in the "Life Safety Code."

### D. TRAVEL DISTANCES

1. Having provided the occupant with at least two paths of travel to an exit, it becomes important that the time needed to travel those paths not be so long as to put the occupant in further danger.
2. The factors influencing travel distances are:
  - a. The number, age, and physical condition of occupants and the rate at which they can be expected to move.
  - b. The type and number of obstructions (storage, seating, heavy machinery, etc.) that must be circumvented.
  - c. The number of people in any room or space and the distance from the farthest point in that room to the door.
  - d. The amount and nature of combustibles expected in a particular occupancy.
  - e. The rapidity with which fire might spread, which is a function of the type of construction, the materials used, the degree of compartmentation, and the presence or absence of automatic fire detection and extinguishing systems.
3. Table II provides guidance in determining the travel distance which ought not to be exceeded in reaching at least one of the exits.

### E. DEAD ENDS, COMMON PATHS OF TRAVEL

1. A dead end or common path of travel occurs when a corridor or another space is so arranged that a person standing in it initially is able to travel in only one direction to reach an exit. Although relatively short dead ends are permitted, it is preferable to eliminate them when possible, for they increase the danger of people being trapped in case of fire or another emergency.
2. There are two types of dead-end corridors – one servicing normally occupied spaces, and one leading to normally unoccupied spaces not containing a means-of-egress. These two conditions have somewhat different safety problems. In the first case, the occupants of the rooms serviced by the dead-end corridor do not have a choice of two directions to an exit and therefore their escape could be prevented altogether should a fire originate in the intervening space. The second case does not pose this problem, because there are no occupied rooms serviced by the corridor. However, people groping their way in a dark or smoke-filled corridor could turn into the second type of dead-end corridor and become confused, as the corridor does not lead to an exit.
3. Sometimes it is very difficult to avoid dead-ends, and there are some little-used spaces that can be conveniently located in a dead-end without undue hazard to those who must frequent these spaces. But a dead-end is never a desirable feature.
4. The terms "dead-end" and "common path" of travel are similar in meaning, but not precisely so, since dead end refers specifically to corridors, while a common path of travel may be an aisle or another nonenclosed space.
5. Table II provides guidance in determining maximum dead-end or common path of travel limits.

### F. WIDTH OF STAIRS, CORRIDORS, PASSAGEWAYS, AISLES

1. The normal minimum width for stairs, corridors, passageways, aisles, and similar access ways is 44 inches.  
Exception 1. Health care facilities: inpatient facilities, minimum of 8 ft.; other health care areas, minimum of 6 ft.  
Exception 2. Existing means-of-egress (excluding assembly occupancies, doorways and stairs) prior to 1989, the width may be reduced to 28 inches.  
Exception 3. Where total occupant load of all floors served by a stairway is less than 50, the stair width may be reduced to 36 inches.



2. Greater widths may be required for large occupant loads (generally more than 200). Consult the "Life Safety Code."

### G. EXIT IDENTIFICATION

1. All means-of-egress are to be clearly visible and conspicuously marked; building occupants should be able to determine the direction of escape from any location. In some locations (e.g., buildings with large floor areas or congested areas) floor markings or other directional aids may be needed.
2. Signs.
  - a. Each required exit from a building is to be identified by an illuminated exit sign. Exit signs are not required for all possible building exits. Only required means-of-egress need to have exit signs. A building's main entrance is usually sufficiently obvious to occupants so that no exit sign is needed.
  - b. An exit sign consists of the word "EXIT" in plainly legible letters not less than 6 inches high with 3/4-inch-wide strokes. Normally, exit signs have white letters on a red background. Red letters on a white background are permitted where this would result in greater visibility. Existing green and white exit signs, which satisfy the other conditions for signs, may continue in use.
  - c. Where an existing egress route does not satisfactorily meet criteria of the "Life Safety Code," but could serve as an escape route in an emergency, and where a modification of this egress route to conform to the "Life Safety Code" is physically or economically not feasible, it may be identified by a sign bearing the words, "EMERGENCY ESCAPE."
  - d. Illumination on the face of an exit sign is to be not less than 5 ft-candles. The use of Underwriters Laboratories-listed, internally illuminated exit signs is preferred. Each internally illuminated exit sign is to have at least two lamps. Burned out lamps illuminating exit signs are to be promptly replaced. Tritium tube and fluorescent tube lights are preferred for low maintenance.
  - e. Directional exit signs are provided in locations where the means of egress is not immediately apparent (i.e., in buildings with complex exit paths), and are to meet the same requirements as regular exit signs.

### H. ILLUMINATION

1. Reliable illumination is to be provided for all egress paths at a minimum of 1 ft-candle at the floor during periods when the building is occupied.
2. In the event of failure of the primary power supply, emergency illumination for the means-of-egress and exit signs is to be automatically provided either by a building emergency supply (e.g., generator or batteries) or by use of Underwriters Laboratories-listed battery-operated emergency lights. High pressure sodium lamps or emergency power circuits should have incandescent elements to compensate for reheat cycles.

### I. IMPEDIMENTS TO EGRESS

1. The means-of-egress is not to be through a room subject to locking.
2. Locks or fastenings which prevent free escape from any building are not to be installed.
3. Where emergency exit doors are not normally used for normal egress and where security, contamination, or other control factors exist, door alarms may be utilized to control exit usage. However, these control considerations will not justify the locking of any required means-of-egress against emergency egress.
4. Hangings or draperies are not to be placed so that they conceal or obscure any means-of-egress. Mirrors are not to be placed on or adjacent to any exit door because this may confuse the direction of egress.
5. The means-of-egress is not to be obstructed by equipment, furniture or other objects. Where this is likely to occur, floor markings, railings, or permanent barriers are to be installed to protect against encroachment.
6. If it is necessary to close off a marked means-of-egress (either temporarily or permanently), this action must first be reviewed by the Department/Division Safety Coordinator and the S&EP Division. The exit sign is to be removed or obscured.



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7. Any door, passage, or stairway which is not a means-of-egress, but which might be mistaken for a means-of-egress, is to be identified by a sign reading "NOT AN EXIT" or similar designation, or by a sign indicating its actual character, such as "TO BASEMENT," "STOREROOM," or "LINEN CLOSET." Stairs that continue beyond the level of discharge (such as to a basement), and where there is no alternate safe egress from this area, is to be interrupted at the level of discharge by partitions, doors, or other physical barriers.

### J DOORS

1. Doors in the required means-of-egress are to be the side-hinged, swinging type. When serving a high hazard area or an occupant load of more than 50, these doors are to swing in the direction of egress.
2. Power-operated doors are permitted if designed such that upon loss of power, with the doors in any position, they are capable of being opened manually to permit escape and the method for doing this is obvious. In the case of a swinging door, both the mechanical and manual actions are to be in the direction of egress.

Exception: Doors needed for containment that cannot be practically designed otherwise. (This requires an exemption request to DOE).

3. Any door equipped with a lock or latch which serves an occupant load of 100 or more, is to be provided with Underwriters Laboratories listed panic hardware; otherwise, the door is to be capable of being opened with a simple twisting motion of a knob or lever.
4. Doors in walls serving as smoke or fire barriers (such as stair enclosures) are normally to be kept closed and are to be equipped with positive latching devices to hold them in the closed position against the pressure of expanding fire gases. A door intended to be kept normally closed is to have a sign reading substantially as follows:

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DO NOT BLOCK  
FIRE EXIT  
Keep door closed

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If such doors need to be kept open, only Underwriters Laboratories listed release devices (usually magnetic) are to be used to hold them open, with the doors designed to close on detection of smoke or activation of the building fire alarm system.



## APPENDIX A

**Classification of Occupancies at BNL  
With Respect to Classifications Found in NFPA 101.**

NFPA 101 Classification	Typical BNL Occupancies
Business	Offices (minor offices incidental to another occupancy are not included) Library Small lecture rooms
Industrial	Laboratories Experimental areas Power plant Maintenance shops Automotive service stations Laundry
Special Industrial	Accelerator tunnels
Storage	Warehouses Garages (no servicing)
Assembly	Cafeteria Berkner Hall Brookhaven Center Recreation Hall Large conference rooms (more than 50 people) Exhibit Hall
Educational	Recreation Hall (when used as nursery school)
Health care	Hospital wing of Medical Research Center (Laboratory wing is Industrial)
Residential	Dormitories Apartments Cottages Mobile homes
Unusual structures	Meteorology towers



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### APPENDIX B

#### Determining Occupant Load

Table I provides occupant load factors used in computing the required capacity of the means-of-egress. Some values are for net area while others are based on gross area. The gross area figure applies to the building as a whole (the area within the exterior confines the building), while the net area figure applies to actual occupied spaces, such as office spaces, and does not include the corridors, the area occupied by walls, or other unoccupied areas. None of the occupancy classifications have values for both the net and gross areas of a building. However, there may be cases of mixed occupancy, (for example, a place of assembly having an occupant load based on net floor area may be located in an office building) where the occupant load is based on **gross** area. A separate calculation is made for those spaces where occupant load is determined on the basis of net area; if the total occupant load determined on the net area basis exceeds that on the gross area basis, the means-of-egress design is based on the larger occupant load figure.



**Table I. Examples of Occupant Load Factors**

<b>Occupancy</b>	<b>Sq Ft per Person</b>
Places of assembly	15 net
Areas of concentrated use without fixed seating	7 net
Standing space	<b>3</b> net
Fixed seating	See NFPA 101
Storage, shipping	300 gross
Office areas	100 gross
Industrial	100 gross
Special occupancies*	
Dormitory and Guest House	200 gross
Health care	
Sleeping areas	100 gross
Other inpatient areas	240 gross

Note: If actual normal occupant load is greater than calculated load, actual occupant load is used to determine required egress capacity.

\*See "Occupancy."



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**Table II. Exit Travel Distances and Dead-End and Common Path of Travel Limits**

Type of Occupancy	Dead-end Limit ft	Travel Limit to an Exit	
		Unsprinklered ft	Sprinklered ft
Places of assembly	<b>20</b>	150	<b>200</b>
Hospital	<b>30</b>	100	<b>150</b>
Residential, e.g., guest house, dormitories	<b>0</b>	100	<b>150</b>
Business, office	<b>50</b>	<b>200</b>	<b>300</b>
Industrial	<b>50</b>	100	<b>150</b>
General	<b>0</b>	75	<b>75</b>
High hazard	**	**	**
Special purpose			
Storage	**	**	**
Low hazard	**	<b>200</b>	400
Ordinary hazard†	<b>0</b>	<b>75</b>	100
High hazard†			
Unusual Structures	**	**	**

\*Where the dead-end or common path of travel services an occupied area, the occupant load served is to be 25 or less; and a fire detection or sprinkler system is to be provided, including alarm devices which can be heard by the occupants.

\*\*No specific requirements. See Section V.

†See NFPA 101 for definitions.